Patriot Fratricides:

The Human Dimension Lessons of Operation Iraqi Freedom

This article identifies network design and operator-controller training problems that have implications for networked-centric operations in the future combat system (FCS) Army. This article is courtesy of the Air Defense Artillery magazine and is appearing in the ADA January-March edition.

Editor

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Soldiers and not an automated system must be the ultimate decision makers in air and missile defense (AMD) engagements. Nearly everyone in the AMD community is aware of the Patriot fratricide incidents that occurred during Operation Iraqi Freedom (OIF). During major combat operations (MCO), two separate fratricide incidents each resulted in the destruction of a friendly aircraft: a British Tornado and US Navy F-18.

The Army has done much to address the perceived causes of these incidents. Now, more than two years after the fact and with many hardware, software, training and procedural changes in the offing, there is a natural tendency to view the problem as "fixed." However, before declaring the "case closed," it may be instructive to look again at what the various official inquiries and the Defense Science Board (DSB) said about the fratricide incidents in its 2004 study[1] and explore the longer term implications of those findings.

Personnel from the Army Research Laboratory's (ARL's) Field Element at Fort Bliss, Texas, started looking into the Patriot system's performance at the invitation of Major General Michael A. Vane, then Chief of ADA [Air Defense Artillery] and Commander of the ADA Center and Fort Bliss. After discussions with the Chief of ADA, we structured an effort named "Patriot Vigilance." The charter was to explore four broad topics: vigilance and situational awareness, trust in automation, Patriot and AMD training effectiveness and efficiency, and AMD leader development. We spent most of the summer and fall of 2004 reading documents, interviewing knowledgeable personnel from around Fort Bliss and observing training and operations.

Our objective in the Patriot Vigilance project was not to conduct another exercise in "Monday-morning quarterbacking." Rather, we wanted to look into the deeper story behind events leading to the fratricides from a human performance perspective. Our focus was on determining the path forward.

Our initial report went to the Chief of ADA in October 2004.[2] Less than a month later, we learned that several of our conclusions were mirrored by the DSB study.

Two DSB Human Performance Conclusions. Two recommendations from the DSB report on Patriot system performance summarize the path forward from a human performance perspective. Although the full report is classified, the following extracts are not.

- "The Patriot system should migrate to more of a 'man-in-the-loop' philosophy versus a fully automated philosophy—providing operator awareness and control of engagement processes."
- "Patriot training and simulations should be upgraded to support this man-in-the-loop protocol, including the ability to train on confusing and complex scenarios that contain unbriefed surprises."

The central notion in the first DSB recommendation is captured in the phrase "providing operator awareness and control of engagement processes." Simply put, Soldiers and not the automated system must be the ultimate decision makers in AMD engagements. Decisions to shoot or not to shoot must be made by crews having adequate situational awareness for the situation at hand and the expertise to understand the significance of the information available to them.

Putting human decision makers back into the control loop does not mean that we try to "turn the clock back" to the good old days of Nike Hercules and Hawk and merely reemphasize traditional control strategies and procedures. The Patriot environment is too complex for that simplistic solution.

Driven by advances in technology and mission changes, Patriot crewmember roles have evolved from traditional operators to supervisors of automated processes. The job of supervisory controller is different from that of a traditional operator, and these differences must be reflected in system design, performance support features (decision aids), and training and professional development.

Moreover, system designers and users are not free to opt for or against casting

operators as supervisory controllers. Operators must be augmented by technology in the form of automation. The contemporary AMD environment is simply too complex and demanding to consider any other approach.

Various organizations have conducted considerable work on the problem of developing an effective man-in-the loop strategy. Specific products in this regard include a new software build, Post Deployment Build 6, which emphasizes and facilitates positive human control, and revised tactical standing operating procedures (SOP) and tactics, techniques and procedures (TTPs) to complement the software changes.

The next step in this process will be to validate and debug the revisions in a series of operational tests and usability assessments. Human Research and Engineering Directorate staff members will be lending their technical expertise to these events scheduled for the summer of 2006.

The second DSB recommendation that has major significance for human performance in contemporary AMD operations concerns training. Here, the DSB was reacting to the AMD community's own conclusion that it is necessary to relook the "level of expertise necessary to operate such a lethal system on the modern battlefield."[3] The AMD community has responded to this challenge with the new Master Gunner and Top Gun Courses. Other training changes are also in process or under consideration.

Navy Fratricide Training Lessons. The Navy faced a similar reconsideration of training practices in the aftermath of the shoot-down of the Iranian airbus by the *USS Vincennes* in 1988. After more than 10 years of research, the Navy reached several conclusions that also are relevant to the AMD setting.

First, the Navy's research indicated that situational awareness is the key factor in determining decision quality in battle command.[4] Situational awareness is built upon in-depth technical and tactical expertise. The primary implication of this conclusion is that marginally skilled or apprentice operator-controllers cannot develop the situational awareness necessary for effective supervisory control, regardless of the sophistication of the battle command hardware suite provided to them.

Technology is important, but it is only part of the solution. Relevant and in-depth operator expertise is an equal factor in developing situational awareness and providing effective human oversight of system operations. Technology can amplify human expertise, but it cannot substitute for it.

The Navy also concluded that Aegis operator-controller training must emphasize the development of adaptive decision-making skills.[5] Adaptive decision-making skills (the ability to "think outside the box" defined by routine crew drills) are key to effective operator-controller performance in ambiguous situations.

The DSB's recommendation to include "unbriefed surprises" in training does not mean that it is sufficient merely to insert anomalous events like those encountered in OIF into training scenarios. In advanced AMD training, the scenario is the curriculum. And to properly prepare operator-controllers for combat, scenario designers must bear in mind that the "surprises" of OIF are representative of a class of potential anomalies. Selected anomalies occurred then; others—some similar, some different—will occur on future battlefields.

Thus, operator-controllers must be imbued with a sense of mindfulness that automated battle command systems are fallible. These systems' recommendations will be correct most, but not all the time.

The third major conclusion was that shipboard training (i.e., unit) must address the team in addition to individual performance.[6] Competent crews are the basis of effective unit performance, and crews are more than the sum of their individual members.

Training must foster the development of the expertise essential to recognize potential anomalies and the skills necessary to determine an appropriate course of action. Operator-controllers must "walk the fine line" between blind faith and wholesale mistrust, but they must not become tentative or "gun-shy."

Patriot is representative of the new class of systems that are more knowledge-intensive than previous generations of military equipment. For the foreseeable future, much of the intelligence necessary to employ such systems effectively must come from the human component. Research and experience have consistently shown that effective automation of knowledge-based functions, such as decision making, planning and creative thinking, remains elusive.

Despite more than three decades of research on artificial intelligence (AI), neural networks and so forth, transfer of "thinking" skills to machines has proven difficult.[7] This reality will require increased emphasis on facilitating essential human oversight for these new systems. Proper oversight is a function of both system design and user training and professional development.

Failure to fully address both these issues means that the fratricide events of OIF, or worse, may recur the next time the system is used in combat. Much has been done to address the problems that occurred during OIF, but the task is not completed.

The motto of the ADA is *First to Fire*. In a sense, a variant of this motto applies to the effective use of automated battle command systems. Problems similar to those Patriot encountered during OIF will face the rest of the Army as the emerging generation of network-centric systems, such as FCS, comes of age. Lessons learned now in ADA can point the way for the Army at large. Because of its technology and operating environment, Air Defense Artillery just got there *first*.

Endnotes:

1. Defense Science Board (DSB) "Patriot System Performance," November 2004
2. ARL, Fort Bliss, also prepared a companion report: "The Human Side of Automation: Lessons for Air Defense Command and Control" (ARL-TR-3468), March 2005. This report is available from the Army Research Laboratory's Fort Bliss Field Element or online through the Defense Technical Information Center (DTIC).
3. Ibid.
4. Janis A. Cannon-Bowers and Edwardo Salas, "Making Decisions Under Stress: Implications for Individual and Team Training." This is a summary report of the US Navy's Tactical Decision Making Under Stress (TADMUS) Project, American Psychological Association, Washington, DC, 1998.
5. Ibid.
6. Ibid.
7. Raja Parasuraman and Victor Riley, "Humans and Automation: Use, Misuse, Disuse, Abuse," *Human Factors*, Volume 39, Edition 2, 1997, 230-252.

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